REMARKS

The claimed invention

The present invention is directed to electromechanical devices that comprise substantially planar electroactive ceramic members. These members have grooves or slots formed therein, for example via laser machining. The grooves allow the ceramic member to conform to a curved surface. The slots multiply an electromechanical bending response of a bimorph ceramic member. The grooves or slots may be arranged, for example, in a substantially parallel or a substantially concentric array.

Claims 17 and 22 has been amended to more particularly point out and distinctly claim the subject matter of the invention. In claim 17, the adjective "electroactive" has been moved to more clearly modify the word "member." Applicant submits that the scope of the claim is not narrowed by this amendment. Claim 17 has also been amended to recite that grooves in the electroactive member are adapted and constructed to reduce transverse strains generated by bending such that the member is capable of bending to conform to a curved surface. Claim 22 has been amended to recite that slots in the bimorph member are adapted and constructed to reduce transverse strains generated by bending to multiply an electromechanical bending response.

The prior art

Ayusawa is a Japanese published patent application that describes a method of forming a compound piezoelectric element. Parallel grooves are formed in a green ceramic sheet and filled in with wax or another removable material. The composite of the green sheet and the wax is sufficiently flexible to be wound into a cylinder. Once wound, the composite is fired to burn out the wax and sinter the ceramic, obtaining a cylindrical element having longitudinal holes therethrough.

Dias is a U.S. patent disclosing an annular array sensor. The sensor is produced by machining annular grooves in the convex side of a shell of piezoelectric material. The cuts "are made almost entirely through the shell [12] so that a small amount of material [20] remains between the cut and the concave side [14]" (abstract, referring to the figures of Dias). The shell itself is "shaped like a section sliced from a spherical shell" (column 5, lines 9-10).

Ikehata is a U.S. patent disclosing a nozzle flapper mechanism including an electrostrictive device comprising a shim and piezoelectric ceramic members disposed thereon (Abstract).

Claims 17, 18 and 20 fulfill the requirements of 35 U.S.C. § 102

Claims 17, 18, and 20 stand rejected under 35 U.S.C. 102 as being anticipated by Ayusawa. The Examiner states that Ayusawa "shows an electroactive ceramic which is capable of being wrapped around a core material." Applicant respectfully disagrees. Applicant submits that Ayusawa discloses cutting grooves in a green material, wrapping the green material into a cylinder, and firing it. Applicant submits that Ayusawa fails to disclose "a substantially planar ceramic electroactive member," as recited by claim 17. The green body disclosed by Ayusawa is composed of PZT, which is an electroactive material, but it is not itself electroactive. The green ceramic has very small grains and significant porosity. It is also very compliant. An electric voltage applied across the green ceramic would not lead to a significant mechanical response, even if individual grains responded to the voltage. The green body must be sintered to create an electroactive member. In addition, after the green body of Ayusawa is fired, there is no indication in Ayusawa that the resulting ceramic can be unwound to create a *planar* electroactive member as recited by claim 17. Thus, Applicant submits that claim 17 is patentable over Ayusawa. Claims 18 and 20 depend from claim 17. Applicant respectfully requests reconsideration and withdrawal of the rejections over Ayusawa.

Claims 17-18 and 21-24 are patentable in view of Dias and Ikehata

Claims 17-18 and 21-24 stand rejected under 35 U.S.C. 103 as being unpatentable over Dias in view of Ikehata. Applicant submits that Dias fails to disclose the use of a substantially planar ceramic electroactive member, as recited by claim 17. Rather, the piezoelectric element disclosed by Dias is curved. Dias discloses a shell of piezoelectric material "shaped like a section sliced from a spherical shell" (column 5, lines 9-10). The shell has a "concave surface [and] a convex surface" (column 5, lines 10-11). In contrast, independent claims 17 and 22 recite a "substantially planar" member. It is clear from the instant application that the planar member is substantially flat. For example, page 5, lines 29-30 describe a planar electroceramic form as a wafer. Dias discloses a curved shell, not a substantially flat wafer. Dias fails to

disclose a "substantially planar ceramic electroactive member" as recited by claim 17 or a "substantially planar bimorph electroactive ceramic member" as recited by claim 22.

Dias also fails to disclose the use of grooves or slots to reduce transverse stresses in an electroactive material. Rather, the slots of Dias enable a single block of material to be machined into a plurality of sensors for an array (see, e.g., column 2, lines 16-18). Indeed, the device of Dias is not meant to be bent into a different shape. Rather, Dias discloses an annular array sensor shaped like a shell, as disclosed at column 2, lines 23-29. Applicant submits that Dias fails to disclose grooves that are adapted and constructed to reduce transverse strains generated by bending such that a planar member is capable of bending to conform to a curved surface, as recited in claim 17, or slots that are adapted and constructed to reduce transverse strains generated by bending to multiply an electromechanical bending response of a bimorph member, as recited by claim 22.

Ikehata fails to remedy the omissions of Dias but discloses a multi-layered electroactive member. To the extent, if any, that Ikehata provides motivation to provide a second layer in the device disclosed by Dias, such a hypothetical device would not be a "substantially planar bimorph electroactive ceramic member" as recited by claim 22 because the device of Dias is curved. Combination of the teachings of Ikehata with those of Dias would not result in the invention recited by claim 22 because neither reference discloses or suggests slots that are adapted and constructed to reduce transverse strains generated by bending to multiply an electromechanical bending response of a bimorph member. Rather, the slots of Dias separate the sensors of an array, as discussed above.

Furthermore, addition of slots to the device of Ikehata would frustrate the purpose of Ikehata's disclosure. The device of Ikehata is a bimorph that is positioned over a nozzle 12 (see Figure 12 of Ikehata). An electrical voltage applied to the bimorph causes it to flex towards the nozzle. The downward force of the bending bimorph opposes the upward force of air ejected from the nozzle. This changes the back pressure of air ejected from the nozzle, introducing a pressure variation into a pilot valve 52 (column 8, lines 13-17). If slots were added to the bimorph, its stiffness would be sufficiently reduced, and the downward force exerted by the bending bimorph would not be sufficient to oppose the upward force of the ejected air. The bimorph would thus "unflex" under the force of the air, causing an unintended pressure variation that would be introduced to the pilot valve and transformed into an output signal unconnected to

an imposed electrical signal (see column 8, lines 15-17). Instead of causing a steady back pressure in response to a current, the bimorph would flex downwards under the influence of the electrical current and upwards in response to air from the nozzle, leading to oscillation, not a stead pneumatic signal. In addition, the added flexibility of a slotted device would cause it to respond not only to current but also to variations in the flow of ejected air and other mechanical vibrations, leaving the device less able to turn an electrical signal into a pneumatic signal (column 1, lines 55-58).

Claims 18, 21, 23 and 24 depend from either claim 17 or claim 22. Applicant submits that claims 17-18 and 21-24 are patentable over Dias and Ikehata, whether considered together or separately.

Claim 19 is patentable over Ayusawa and Dias

Claim 19 stands rejected under 35 U.S.C. 103 as being unpatentable over either of Ayusawa or Dias. Applicant respectfully disagrees. Applicant respectfully submits that this claim depends from claim 17, the patentability of which is discussed above. In addition, Applicant submits that Dias fails to disclose or suggest a substantially planar ceramic electroactive member, as recited in claim 17, that can conform to a curved surface having a radius of curvature no greater than 0.25", as recited in claim 19. As discussed above, Dias only discloses materials that are already curved. The addition of grooves in Dias does not enable further bending but enables an array of sensors to be fabricated from a single piece of material. Likewise, Ayusawa fails to disclose a substantially planar ceramic electroactive member in which grooves are adapted and constructed to reduce transverse strains generated by bending such that the member is capable of bending to conform to a curved surface having a radius of curvature no greater than 0.25", as recited by claim 19. Rather, Ayusawa discloses a green body that is wrapped into a cylinder. As discussed above, the green body is not electroactive. Once it is sintered, the resulting product will be too brittle to straighten back into a planar shape. As a result, Applicant respectfully requests reconsideration and withdrawal of the rejection of claim 19.

Claim 25 is patentable over Ayusawa and Ikehata

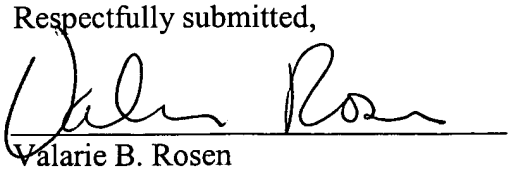
Claim 25 stands rejected under 35 U.S.C. 103 as being unpatentable over Ayusawa in view of Ikehata. Applicant respectfully submits that claim 25 depends from claim 22, the patentability of which is discussed above.

Ikehata does not teach how to modify Ayusawa to achieve the device recited in claim 25. The Examiner states that it would have been obvious to provide a second layer so that the ceramic member could be driven with more power. However, Ikehata fails to disclose the availability of additional power or to suggest that this is desirable. Rather, the additional layer is combined with the first layer to cause the entire device to flex in response to a voltage. The multilayered structure of Ayusawa is too stiff to flex significantly. An additional layer added according to the teachings of Ikehata would further increase the stiffness of Ayusawa's device. Addition of slots to the device of Ikehata would reduce the sensitivity and precision of the sensor of Ikehata, as described above.

The combination of Ikehata with Ayusawa would not result in the inventive device because the device of Ayusawa is already multilayered. As viewed in cross-section, the device of Ayusawa has many layers resulting from winding a green ceramic about a central core. If additional layering is desired, a longer strip of green ceramic may be wound around the central core, as disclosed in the abstract ("The green sheet . . . is wound around a tubular or cylindrical core 24 as much as the desired number of turns."), attached as an appendix. Applicant respectfully requests reconsideration and withdrawal of the rejection.

A Petition for Extension of Time and the appropriate fee are enclosed. Please charge any additional fees associated with this filing, or apply any credits, to our Deposit Account No. 03-1721.

Respectfully submitted,



Valarie B. Rosen
Registration Number 45,698
Date: March 30, 2004

Choate, Hall & Stewart
Exchange Place
53 State Street
Boston, MA 02109
(617) 248-5000
3672490_1.DOC

PATENT ABSTRACTS OF JAPAN

(11)Publication number : **64-025583**
(43)Date of publication of application : **27.01.1989**

(51)Int.CI. **H01L 41/22**
H04R 17/00
// B32B 7/02
C04B 35/64

(21)Application number : **62-182662**
(22)Date of filing : **22.07.1987**

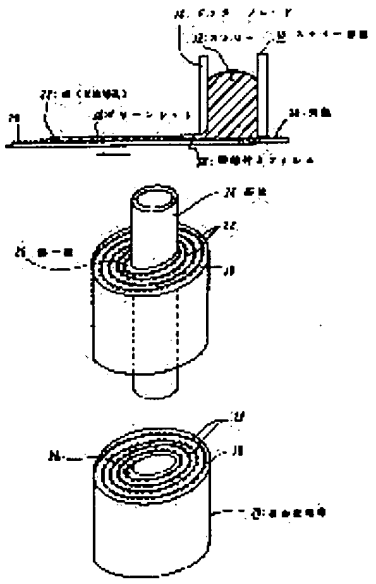
(71)Applicant : **OKI ELECTRIC IND CO LTD**
(72)Inventor : **AYUSAWA KAZUTOSHI**
SATO TOYOSAKU

(54) MANUFACTURE OF COMPOSITE PIEZOELECTRIC ELEMENT

(57)Abstract:

PURPOSE: To form a compound piezoelectric element used for acoustic sensor, etc., simply and easily, by shaping a piezoelectric ceramics green sheet where a number of grooves extending in the direction of sheet width are arranged in the delivery direction of the sheet and by burning the green sheet after winding it around a core which will beburned out by burning.

CONSTITUTION: As a corrugated film 16 is delivered, slurry 12 is transferred onto a film 16 with the thickness thereof being controlled by a doctor blade 14, then becomes a green sheet 18. A number of stripe grooves 22 extending full widthwise of the green sheet 18 are formed with equal spaces along the longitudinal direction of the sheet. The green sheet 18 having PZT grooves thus formed is wound around a tubular or cylindrical core 24 as much as the desired number of turns. A material such as plastics or wax which burns out at burning is desirable for the core 24. The tubular form obtained in this way is burned at a proper temperature in PbO atmosphere to burn out the core 24. As a result, the burnt PZT, that is a composite piezoelectric 28 of PZT and air, having a number of holes through a tube longitudinally can be acquired.



LEGAL STATUS

[Date of request for examination]

[Date of sending the examiner's decision of rejection]

[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]

[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]